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Clinical Report

Acute Equine Colic due to the Diaphragmatic Hernia: Two Cases

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ABSTRACT

Diaphragmatic hernias are an uncommon cause of abdominal pain in horses. The following case report describes a diaphragmatic hernia in 2 adult horses with signs of acute colic. A six-year-old stallion and a seven-year-old mare were referred to the emergency duty for severe abdominal pain; for a six-month period from late 2021 to early 2022. The horses were subjected to explorative laparotomy, which revealed a migration of the large colon associated with volvulus (in stallion); and small intestine protrusion (in mare) in thoracic space. Necropsy revealed a diaphragmatic chronic rupture (approximately 13 centimeters in diameter) in the left mid-region with the protrusion of the large colon in the thoracic cavity in the male horse; and a diaphragmatic acute rupture (approximately 3 centimeters in diameter) in the left dorsolateral region with the incarceration of jejunum in thoracic cavity in the mare. This case report demonstrated that a diaphragmatic hernia should be considered as a differential diagnosis in equine colic.

Introduction

Diaphragmatic hernia (DH) is a condition characterized by entry of one or more abdominal organs into the thoracic cavity through a defect in the diaphragm.[1] This type of hernia is often reported as a rare lesion in the horse with an incidence of 0.7–2.1%. The incidence of this disease, however, is probably higher.[2] Many DH are diagnosed at necropsy or slaughter incidentally, which suggests that not all affected horses require treatment.[3] DH should be included in the differential diagnosis of horses presenting with colic symptoms.[4] DH may be congenital or acquired. The congenital hernia happens due to incomplete fusion of the embryonic parts of the diaphragm, and is usually small, have smooth edges and found in the tendinous part of the left dorsal quadrant. The acquired hernia or diaphragmatic rupture may occur due to trauma, strenuous exercise, parturition, dystocia and increased intra-abdominal pressure.[5] The acquired diaphragmatic rupture can be acute or chronic. The acute hernia has raw, irregular and bleeding edges, while the chronic ones have thick, smooth and fibrous edges, often accompanied by adhesions between the diaphragm and the protruded organs.[1,5] The most organs that are incarcerated in DH are the small and large intestines, but the spleen, the stomach and the liver can also be entrapped.[4] There

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does not appear to be an age, breed, or sex predisposition to DH.[6] Clinical signs of DH are variable and are usually related to the type of viscera entrapped and portion and amount of intestine herniated. In case of small defects, only small intestine can herniate and clinical signs frequently include acute abdominal pain. In case of a large defect the colon herniates and the horse presents chronic and intermittent colic.[7] Preoperative diagnosis of DH can achieve by imaging techniques such as ultrasonography and radiography, but definitive diagnosis is often obtained during surgery or necropsy.[8] Treatment is exclusively surgical intervention and includes removing the herniated bowel from the thorax, with or without resection, and repairing the diaphragmatic defect.[9] Diaphragmatic herniorraphy technique is challenging and large dorsal defects are more difficult to repair.[10] Post-operative medication should comprise management of pneumothorax and pleuritisin addition to the routine colic treatment regimen.[9] This report describes the acquired DH in two horses with colic symptom, which were referred to the large animal teaching hospital of Veterinary Faculty of Tehran University.

Case Description (Case 1)

A 6-year-old mix thoroughbred stallion, approximately 400 kg body weight, was referred to the Hospital with a history of acute colic of 12 hours duration. The horse did not respond well to initial management in the field (flunixin meglumine 1 mg/kg). The owner declared that the horse has shown symptoms of decrease in appetite, respiratory depression and exercise intolerance since one month. Clinical examination demonstrated depression, and abdominal pain (i.e., rolling, restlessness), with a heart rate of 80 beats per minute, CRT about 3 seconds, and a rectal temperature of 38.5° C. His respiratory rate was 45 breaths per minute with nostril flaring. Thoracic auscultation showed decreased respiratory sounds and intestinal borborygmi, combined with muffled heart sounds and dullness on percussion. Abdominal auscultation revealed tympanic sounds in the right dorsal quadrant and percussion revealed a high-pitched (ping) over the cecum. In rectal examination cecal distension, displacement of the pelvic flexure and firm feces in the small colon was diagnosed. There was no nasogastric reflux present. Based on the trans-rectal and physical examination findings, it was assessed that the stallion suffered from a severe, strangulating colic, suspected to be large colon volvulus, and emergency exploratory celiotomy was recommended and accepted by the owner.

General anesthesia was induced with xylazine (1.1 mg/kg, intravenously [IV]), ketamine (2.2 mg/kg, IV), and diazepam (0.02 mg/kg, IV) and was maintained with isoflurane in oxygen. The horse was positioned in dorsal recumbency and prepared for aseptic ventral median celiotomy. A 30 cm ventral midline incision was made from the umbilicus to xiphoid. The cecum was distended and positioned more cranial than normal. The left large colon was not visualized at their normal location. Palpation of the cranial abdomen showed that the large colon was incarcerated in a rent in the dorsal left side of the diaphragm (Figure 1). The edges of the rent were smooth. The abdominal incision was extended cranially to the xiphoid cartilage to allow better exposure. At that stage, attempts to retrieve the abdominal organs from the thorax into the abdomen were unsuccessful, and the horse's condition became deteriorating during operation and respiratory and cardiovascular distress was noted and the horse subsequently died.

Treatment and Outcome

The post-mortem examination revealed yellowish liquid filling the thoracic cavity, the lung lobes were collapsed, and congested. There was a 13 cm long defect in the left crus of the mid-diaphragm at the border of the muscular and fibrous portions of the diaphragm that extended dorsally. The margins of the rent were thick and fibrotic. Multiple loops of the left dorsal and ventral colon were found in the thoracic cavity and appeared thickened and compromised. The left colon was twisted and edematous and the

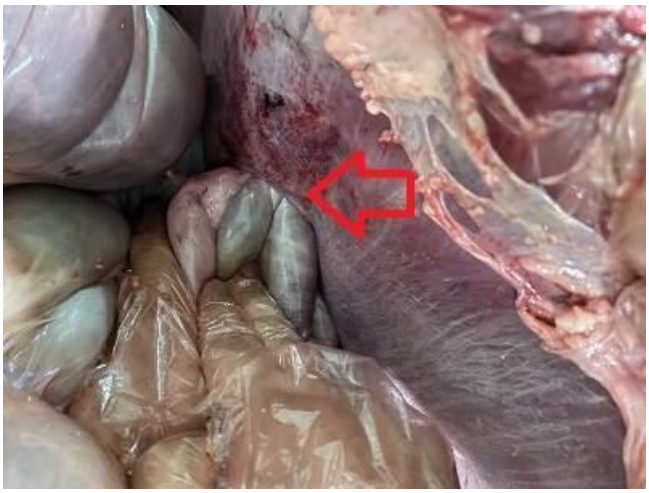

Figure 1. Diaphragmatic rent with protrusion of large colon (arrow) in the thoracic cavity; case 1.

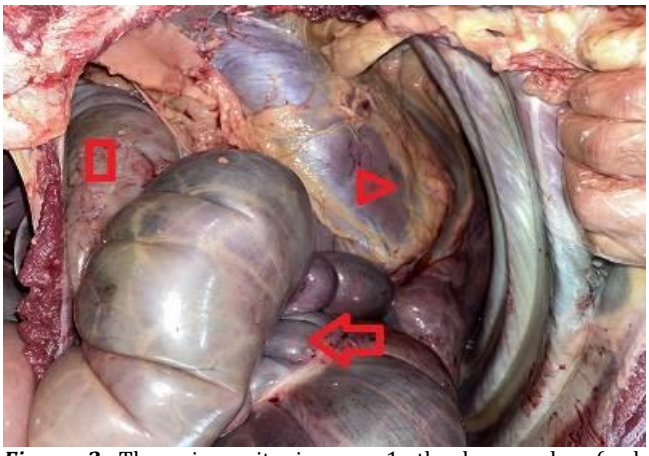

Figure 2. Thoracic cavity in case 1, the large colon (red arrow) migrated in the thoracic space and pressured on the heart (triangle) and the lung lobes (rectangle).

Figure 3. Diaphragmatic rent about 13 cm long in the left side of muscular part of diaphragm, the edge of rent was round and fibrotic; case 1.

mesenteric vessels were congested. There was no evidence of visceral adhesion in the rent edge and thoracic cavity. The pericardium and myocardium seem to be normal (Figures 2 and 3). In close examination of chest wall, the callus formation in mid-portion of the left 9th and 10thintercostal space was observed. The ribs bone was normal, without any sign of fractures. It seems the callus formation resulted from periosteal reaction due to the blunt trauma to the chest wall.

Case Description (Case 2)

A 7-year-old thoroughbred mare with severe colic was referred to the Large Animal Hospital of the University of Tehran. According to the history, the mare presented acute onset, in-appetence, reduced fecal output for 12 hours. Emergency medical treatment including fluid therapy, anti-inflammatory and analgesic therapy (flunixin meglumine, detomidine) used during 12 hours before admission. Clinical examination revealed marked restlessness, elevated heart rate (100 beats/minute) and respiratory rate (30 breaths/min), normal body temperature (37.8° C), moderate dehydration, delayed CRT (5 s), congested mucous membrane, toxic line around the teeth, poor peristalsis and mild abdominal distension. According to physical examination findings, emergency exploratory celiotomy was mandatory and accepted by the owner.

Treatment on Outcome

The patient was then premedicated intravenously with xylazine (0.5 mg/kg), and induction was performed with ketamine (2.2 mg/kg) and diazepam (0.2 mg/kg). The mare was positioned in dorsal recumbency and isoflurane was used for maintaining of anaesthesia. After surgical preparation of the abdomen, a midline incision was made as before. Following decompression of the cecum by IV catheter (G:14), several loops of distended small intestine were emerged through the incision and incarcerated jejunum in tendinous portion of diaphragm was detected. The entrapped bowel couldn't be pushed back from the diaphragmatic defect, therefore, jejunal enterotomy was performed and gentle manipulation was continuously resumed until the strangulated jejunum which was approximately 9 meter long with adhesion originating from greater omentum were released (Figure 4). The interesting point was intra-abdominal hemorrhage and huge amount of blood clots presumably oriented from mesentery and greater omentum ruptures. Resection and end to end anastomosis of the affected intestinal segments were carried out. Unfortunately, the diaphragmatic defect was more dorsal and inaccessible to be closed by suturing as well as the hemorrhage originated from mesenteric arteries couldn't be controlled. The viscera were completely washed with warm lactate ringer and pulled in and ventral midline was closed routinely. The procedure took about 3 hours and the horse recovered excellent. Postoperative treatment included IV administration of 22000 IU/kg sodium benzylpenicillin QID, 6.6 mg/kg gentamicin BID and 1.1 mg/kg flunixin meglumine BID. The fluid therapy was administered with isotonic crystalloid solution (3 ml/kg/h, IV) during and after surgery. The patient was carefully monitored during 18 hours after recovery, however, despite all the hard work, the heart rate increased (from 65 beats/minute after surgery to 90 beats/minute) and lead to hypovolemic shock and the mare died.

Post mortem examination confirmed a dorso-laterally defect in musculo-tendinous junction of diaphragmatic, approximately 3 cm in the right side included greater omentum attachment with a significant amount of blood clots (Figure 5). The margin of opening was inflamed, swelled and congested. In addition, hemothorax and right lung lobe congestion was observed.

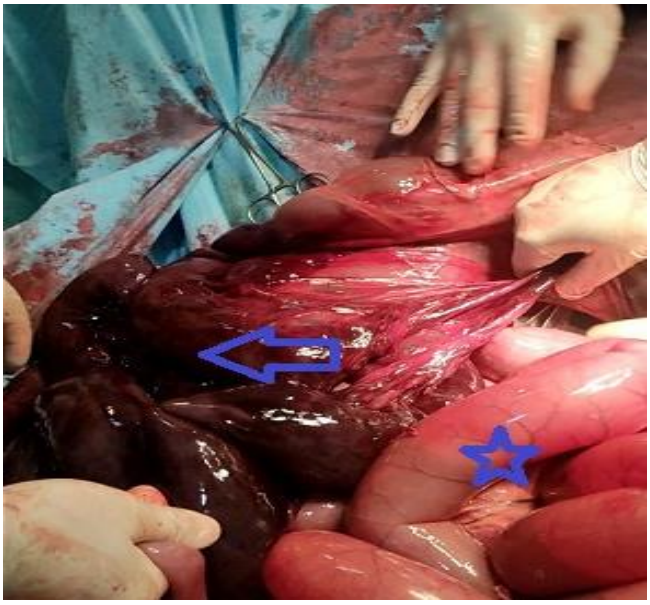

Figure 4. The devitalized small intestine (arrow) was retracted from diaphragmatic rent; the jejunum was gaseous and full of liquid (star), case 2.

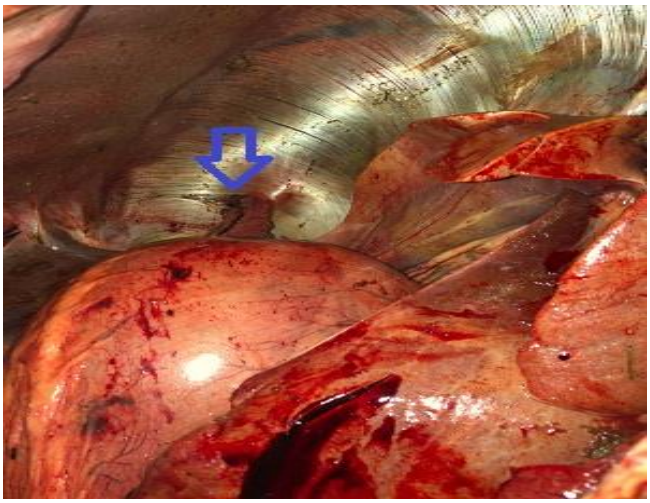

Figure 5. Small rent about 3 cm long with greater omentum adhesion (arrow) in right side of diaphragm; case 2.

Clinical Relevance

Acquired DH may result from a traumatic event resulting in increased intra-abdominal pressure such as parturition, external blunt trauma, or heavy exercise.[10] In our case (case 1), periosteal reaction in the 9th and 10th ribs declare that probably old blunt trauma to the chest wall resulted in rupture of muscular part of diaphragm, although the owner was unaware of the history of trauma. Formation of fibrous tissue at the margins of the defect and presence of callus on rib bones indicates chronic involvement of diaphragm. On the other hand, lack of visceral adhesion in the hernia margin and also in the thoracic cavity is the reason for acute colon protrusion. Santschi *et al*. in 1997 stated that the presence of omental adhesions to a callus on fractured ribs on the thoracic side of the defect is suggestive of previous trauma, possibly at birth.[11] In case 2 of our report, we did not find any history of predisposing factors for occurrence of DH, but based on the necropsy finding, both diaphragmatic rupture and small intestine protrusion was fresh. Most of the acquired diaphragmatic hernias are chronic at the time of diagnosis; a few ones had evidence of recent enlargement of a previously existing tear.[5]

Hart and Brown, 2009 stated that the left side of diaphragm appeared to be affected more often than the right. A functional difference in muscle thickness and length between the costal, sternal, and crural portions of the diaphragm may cause this variation. Recent reports demonstrated the medial costal region was significantly thicker than the ventral and dorsal costal regions, and the crural diaphragm was significantly thicker than any costal diaphragm region.[10] In the case 1 of our report, similar to the recent study, hernia rent was made in left side and crural portion of diaphragm and extended dorsally, while in case 2 the diaphragmatic defect was observed in the right side, indorso-laterally region. Based on several case reports, most of congenital DH located in ventral part and most of acquired DH in left dorsal part of diaphragm, probably because the liver acts as a protection on the right side.[4,5]

DH is typically difficult to diagnose, even during pre-operative evaluation. The clinical findings of DH include acute abdominal signs or colic; colic and dyspneic signs may be consecutive or simultaneous, and only seldom do respiratory signs occur alone.[12] In Santchi case study in 1997, diaphragmatic hernia was not diagnosed before surgery in any of 3 cases horses. They declared that pre-surgical diagnosis of diaphragmatic hernia with abdominal pain can be challenging because of a lack of clinical signs localizing the lesion to the thorax.[11] Most commonly, DH is diagnosed either at abdominal exploration or at necropsy, mainly due to the acute nature of the colic requiring urgent surgery.[5,13]

Radiographs and ultrasonography are the most useful diagnostic devices for attaining ante-mortem or pre-operative diagnosis of DH.[5,7] In the current study, both cases had shown sever colic sign and because of emergency situation, they were immediately referred to recovery room for induction of anesthesia and our definitive diagnosis was based on abdominal exploration.

Surgical intervention is the only definitive treatment for DH. The prognosis of DH is not good generally, and it largely depends on early diagnosis, on the location and length of the tear, and on the degree of intestinal damage.[9,10] The size of the hernia is associated with the severity of clinical signs, as smaller rents are more likely to be constrictive once intestine does enter the ring. These smaller defects are also associated with the herniation of small intestine. Larger defects appear to be associated with the herniation of larger organs, such as large colon.[14] In our study, in case 1, length of the rent was large (13 cm long) and caused large colon migration, and in case 2, size of the rent was small (3 cm long) and small intestine protruded in thoracic cavity. Hernias that located dorsally were associated with a worse prognosis than those located ventrally, because access in dorsal region of diaphragm is more difficult and making closure very difficult or impossible in some cases.[10] In the current study, in both cases the rent located in dorsal part of diaphragm and suture of the rent from abdominal cavity approach was impossible technically. Advance techniques in surgical treatment of DH such as laparoscopy or thoracoscopy may be providing approach for horses in which rents are located dorsally.[10] Kamus *et al* in 2022; have reported dorsally located DH in 3 horses that closure of the defect was performed through a thoracoscopic approach in all cases, successfully.[15]

Factors that negatively affected survival rate including involvement of more than 50% of the small intestine, age of the horse older than 2 years, dorsal location of the defect, and a rent greater than 10 cm in diameter.[1] In Hart and Jenifer case serial study in 2009,[44] horses involved DH was investigated and showed that prognosis for diaphragmatic hernia in horses is poor, with only 16% of horses surviving to discharge.[10] In Romero and Rodgerson retrospective study in 2010, from 31 horses involved DH, 7 cases (23%) discharged from hospital after surgery and the rest of horses were euthanized before, during or after operation.[4] The prognosis of DH for horses had been listed as poor, but in recent reports it has been improved due to the several factors, including the ability to successfully anesthetize systemically compromised patients using precise, controlled ventilation; continuous direct blood pressure monitoring; marked improvements in gastrointestinal surgery techniques; and development of thoracoscopic techniques and surgery.[9]

Many intra-operative complications have been reported in horses during DH repair such as failure to reduce the herniated organs, irreparable intestinal disorders, irreparable diaphragmatic defects, difficulty in maintaining efficient ventilation and oxygenation, bilateral pneumothorax, intestinal, omental and liver adhesions, and rupture of bowel or tearing of vessels. Post-operative complications include ileus, dehiscence of the diaphragmatic defect repair, additional diaphragmatic tearing, pneumothorax, pleural effusion, respiratory failure, septic pleuritis and adhesions.[16]

In conclusion, although DH is an uncommon lesion in horses, it is not exceedingly rare, so it should be considered as a differential diagnosis in equine colic. The diagnosis can be confirmed in exploratory laparotomy and palpation of the diaphragm is advised during the exploration. To the authors' knowledge, this report is the first documented data about occurrence of traumatic diaphragmatic hernia in horses.

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Conflict of Interest

The authors declare that they have no competing interests.

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